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MATHEMATICAL METHODS IN ECONOMY AND INDUSTRY

XVII

Joint Czech-German-Slovak Conference

Berlin

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2012

Conference Programme and Abstracts

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Mathematics for key technologies

HUMBOLDT-UNIVERSITÄT ZU BERLIN

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The DFG Research Center Matheon develops mathematics for key technologies and supports partners in industry, economy and science. Matheon also cooperates with schools and the general public. Founded in 2002, Matheon is a joint initiative of the three Berlin universities (FU, HU and TU) and the mathematical research centers (WIAS and ZIB).

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Welcome address

Dear participants,

welcome to this 17th Joint Czech-German-Slovak Conference on Mathematical Methods in Economy and Industry. It is the latest in an impressive series of meetings that started in 1973 in Zadov (for a history of this conference series see page 8). We are happy to receive at the outskirts of Berlin an interesting mixture of long-standing colleagues, good friends, celebrated mathematicians and talented young researchers. Their talks cover a broad range of applied mathematics reaching from continuous over stochastic to discrete optimization, from variational analysis to finance and from optimal control to convex analysis. Traditionally, this conference enjoys a relaxed atmosphere allowing for extensive discussion during and after the talks, for starting new cooperation but also for physical recreation. Therefore, our choice for a conference venue fell on Akademie Berlin-Schmöckwitz which is close enough to the city of Berlin to be reached with a reasonable effort and which is far enough from the city of Berlin to ensure that participants stay in contact during the whole meeting. The place is embedded into a beautiful wooded area surrounded by lakes, thus giving you quite a different impression about Berlin (yes, we are still in Berlin here! but you leave the official border of the city after 100 metres). You are invited to enjoy both the atmosphere of intensive mathematical discussion and of relaxed communication in a nice environment, not least during the barbecue on Wednesday. It goes without saying that the success of a conference heavily depends on the support by many people. In this respect, we would like to express our particular gratitude to Andris Möller (Weierstrass Institute Berlin) for his dedicated work in the local organization committee. Further thanks go to Margitta Teuchert, Petra Frank, Silvia Burisch, Anke Giese, Konstantin Emich, Thomas Arnold (all Weierstrass Institute Berlin), Holger Heitsch (Humboldt University Berlin). We thank all members of the Scientific Committee for their valuable cooperation and suggestions. Last but not least we gratefully acknowledge financial support by Weierstrass Institute Berlin, DFG Research Center Matheon and Humboldt University Berlin.

We wish all participants a pleasant and scientifically fruitful stay in Berlin and hope that our meeting will increase the appetite for the next meeting in this traditional congress series.

René Henrion
Weierstrass Institute Berlin

Werner Römisch
Humboldt University Berlin

MMEI Conference Series

Prof. František Nožička

The series of International Conferences on Mathematical Methods in Economy and Industry (MMEI) was established in 1973 by Prof. František Nožička (1918 – 2004). František Nožička was professor at the Faculty of Mathematics and Physics of the Charles University in Prague. In addition, from 1966 until 1988 František Nožička was guest professor at Humboldt University Berlin, where he founded the mathematical optimization department. The intention of the MMEI conference series was to tighten a fruitful scientific collaboration between mathematicians from the former GDR and ČSSR who were engaged in optimization theory and practice. After the political upheavals in Eastern Europe the conference series maintained its significance for the scientific colloboration of mathematicians from the Czech Republic, Germany and Slovakia. Moreover it extended its appeal to further neighbouring countries. The conference traditionally covers a wide range of mathematical methods applied to economy and industry. The emphasis is laid on optimization theory, both deterministic and stochastic.

The following list contains MMEI conferences so far.

1.	24.09.1973 – 28.09.1973	Zadov, Czechoslovakia (organized by UK PRAHA)
2.	21.10.1974 – 24.10.1974	Heiligendamm, DDR (organized by HU Berlin)
3.	09.02.1976 – 13.02.1976	Zvíkovske Podhradí, Czechoslovakia (organized by UK PRAHA)
4.	02.10.1977 – 08.10.1977	Vitte/Hiddensee, DDR (organized by HU Berlin)
5.	11.02.1979 – 16.02.1979	Smolenice, Czechoslovakia (organized by VSE Bratislava)
6.	28.09.1980 – 03.10.1980	Vitte/Hiddensee, DDR (organized by HU Berlin)
7.	30.08.1982 – 03.09.1982	Praha, Czechoslovakia (organized by UK PRAHA)
8.	26.10.1984 – 31.10.1984	Sellin/Rügen, DDR (organized by HU Berlin)
9.	20.09.1992 – 25.09.1992	Loučná, Czechoslovakia (organized by UK Praha and HU Berlin)
10.	25.09.1995 – 30.09.1995	Bardejovské kúpele, Slovakia (organized by TU Košice)
11.	01.06.1998 – 05.06.1998	Liberec, Czech Republic (organized by TU Liberec)
12.	21.07.2002 – 26.07.2002	Arnstadt, Germany (organized by HU Berlin)
13.	26.05.2003 – 30.05.2003	Hejnice, Czech Republic (organized by TU Liberec)
14.	23.05.2005 – 27.05.2005	Arnstadt, Germany (organized by HU Berlin)
15.	04.06.2007 – 07.06.2007	Herľany, Slovakia (organized by P.J. Šafárik University and TU Košice)
16.	15.06.2009 – 18.06.2009	České Budějovice, Czech Republic (organized by University of South Bohemia)
17.	24.06.2012 – 28.06.2012	Berlin, Germany (organized by WIAS and HU Berlin)

General information

Venue - Akademie Berlin-Schmöckwitz

The conference is held at Akademie Berlin-Schmöckwitz GmbH. The conference venue is a nice place in the wooded outskirts of Berlin surrounded by several beautiful lakes.

The history of the estate can be backtracked until the beginning of 20th century when it was used as a farm. The Manor house was built from 1919 until 1921 based on construction drawings by Max Bieroth from Berlin. After World War II it was used by the soviet military administration and later by a governmental establishment of the GDR. After the changes in 1989 and 1990 the object was leased by InBIT, a professional training company. The Akademie Berlin-Schmöckwitz, finally, was founded in 1997 as an outsourcing of InBIT.

Akademie Berlin-Schmöckwitz is engaged in basic and advanced vocational training as well as in organization of conferences and events.

Address:
Akademie Berlin-Schmöckwitz GmbH
Wernsdorfer Straße 43
12527 Berlin
GERMANY

Homepage:
`http://www.akademie-schmoeckwitz.de/`

Presentation Guidelines

All presentations should be made in English. Contributed talks are limited to 25 minutes + 5 minutes discussion.

The lecture rooms (“Müggelsee” and “Wernsdorfer See”) are located on the ground floor of the seminar building. All lecture rooms are equipped with video projector and whiteboard. A Laptop with pdf-viewer is available. Speakers should bring their presentation on a usb flash drive and have the technical assistant transfer it to the PC at least 15 minutes before the start of the session. Authors whose presentations contain animations, videos or special effects are strongly encouraged to use their own notebook.

Meals

The meals are served as bufett at the restaurant in the Manor house. Meal times are as follows:

Breakfast: 07:30 Lunch: 12:30 Dinner: 19:00

Drinks at lunch and dinner are not covered by the conference fee and have to be payed by yourself. Please note that consumption of foods and drinks brought from outside is not permitted on the conference site including the seminar building and the restaurant.

Barbecue

At Wednesday, June 27, 2012 there will be a barbecue (starting at 19:00) instead of dinner. Your personal conference documents contain three vouchers each useable for one drink (beer, wine or softdrink) at this evening. Additional drinks have to be paid by yourself.

Internet Access

Akademie Berlin-Schmöckwitz provides internet access by WLAN which is covered by the conference fee. Detailed information will be made available during the conference.

Leisure Facilities

The location of Akademie Berlin-Schmöckwitz in front of the Berlin forest is ideal for hiking, jogging and biking. It is possible to rent a bike or a small boat. There are several places for swimming in the surrounding area, in particular at lake Krossinsee wich is close to the hotel. There is also the possibility to play volleyball, soccer or badminton.

Moreover, Akademie Berlin-Schmöckwitz offers great wellness programs: sauna, massage (classic and Ayurvedic) as well as cosmetics.

Conference Schedule

Sunday, June 24, 2012

	Arrival and Registration

Monday, June 25, 2012

Time	Room "Müggelsee"
08:45 - 09:00	**Opening Ceremony**
09:00 - 10:00	**Plenary lecture** (Chair: R. Henrion) **Boris Mordukhovich:** Optimal Control of the Sweeping Process (p. 15)
Coffee break	
10:30 - 12:30	**Contributed talks** (Chair: P. Lachout) **Karel Zimmermann:** Optimization Problems under Two-sided Max-separable Inequatilty Constraints. (p. 18) **Richard Cimler:** Periodic behavior of max-t fuzzy systems (p. 19) **Hana Tomášková:** Application of circulant and Toeplitz max-min matrices (p. 19) **Helena Myšková:** Efficient Algorithm for Checking robustness of interval fuzzy matrices (p. 19)
Lunch	
14:00 - 15:00	**Plenary lecture** (Chair: S. Vogel) **Jitka Dupačová:** Minimax stochastic programs and beyond (p. 15)
Coffee break	
15:30 - 17:30	**Contributed talks** (Chair: K. Zimmermann) **Igor Melichercik:** Optimal fund management with gradual contributions (p. 20) **Martin Tóth:** Real Options with CRRA utility function and finite project life (p. 20) **Darina Graczova:** Dynamic Accumulation Model with Fat-tailed Distributed Returns (p. 20) **Zuzana Zíková:** Three - factor convergence model of interest rate (p. 21)

Tuesday, June 26, 2012

Time	Room "Müggelsee"
09:00 - 10:00	**Plenary lecture** (Chair: D. Klatte) **Juan Enrique Martínez-Legaz:** DC functions: subdifferential analysis, duality and Lipschitz continuity (p. 16)
	Coffee break
10:30 - 12:30	**Contributed talks** (Chair: J. Outrata) **Diethard Klatte:** A Class of Nonsmooth Newton Methods Revisited (p. 21) **Lukas Adam:** Necessary Optimality Conditions for a Optimal Control Problem Governed by an Inclusion with Discontinuous Right–Hand Side (p. 22) **Stefan Vigerske:** Solving MINLPs with SCIP (p. 22) **Thomas Arnold:** Solving Mixed Integer Problems with Chance Constraints – An Example (p. 22)
	Lunch
14:00 - 15:00	**Plenary lecture** (Chair: I. Melichercik) **Katarina Cechlarova:** How to compute equilibrium prices in exchange economies with indivisible goods (p. 16)
	Coffee break
15:30 - 17:30	**Contributed talks** (Chair: K. Cechlarova) **Martin Smid:** Estimation of the Fair Price at the Market with Partially Informed Market Maker (p. 23) **Eva Pillárová:** Equitable cake division (p. 23) **Michal Cervinka:** Oligopolistic competition in an electricity spot market with production bounds (p. 23) **Konstantin Emich:** Strategic bidding and generalized Nash equilibrium on the EPEX Spot (p. 24)

Wednesday, June 27, 2012

Time	Room "Müggelsee"
09:00 - 10:00	**Plenary lecture** (Chair: B. Mordukhovich) **Jiri V. Outrata:** On the joint effect of Mangasarian-Fromovitz and Constant Rank qualification conditions in stability analysis of generalized equations (p. 17)
	Coffee break
10:30 - 12:30	**Contributed talks** (Chair: J. Dupačová) **Werner Römisch:** Quantitative stability of stochastic generalized equations (p. 24) **Holger Heitsch:** Quasi-Monte Carlo algorithms and two-stage stochastic programs (p. 24) **Hernan Leovey:** Efficient Computation of Optimal Weights for Lattice Rules in High Dimensional Integration (p. 25) **Milos Kopa:** A Linear Formulation of High-order Stochastic Dominance Criteria (p. 25)
	Lunch
14:00 - 15:00	**Plenary lecture** (Chair: J.E. Martinez-Legaz) **Matthias Gerdts:** Optimal control of differential-algebraic equations (p. 17)
	Coffee break

	Room "Müggelsee"	Room "Wernsdorfer See"
15:30 - 17:30	**Contributed talks** (Chair: M. Gerdts) **Chantal Landry:** An optimal control problem in the optimization of production lines (p. 26) **Dana Botesteanu:** How does the effort a mother bird expends on her offspring depend on the attractiveness of her mate? (p. 26) **Zuzana Němcová:** Orbit period in max-t fuzzy algebra (p. 27) **Štefan Berežný:** On strong robustness, robustness and weak robustness of interval fuzzy matrices (p. 27)	**Contributed talks** (Chair: M. Kopa) **Petr Lachout:** Probabilistic constraints as a multifunction (p. 27) **Andris Möller:** Joint chance constraint programming for blending problem in brass casting industry (p. 28) **Michal Houda:** Stability of convex approximation of chance-constrained problems with structural dependence (p. 28) **Martin Branda:** Chance constrained problems: penalty reformulation and performance of sample approximation technique (p. 28)
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Thursday, June 28, 2012

Time	Room "Müggelsee"
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Lunch	

Abstracts

Invited plenary talks

Room "Müggelsee" **Monday, June 25, 2012** **09:00 – 10:00**
Chair: R. Henrion

Optimal Control of the Sweeping Process

Boris Mordukhovich, Wayne State University, Detroit, USA

This talk is devoted to a new class of optimal control problems for the sweeping (Moreau) process, where control functions enter the moving sweeping set. The dynamics of the control problem is governed by a discontinuous dissipative differential inclusion with variable right-hand sides of the type, which has never been studied in optimal control. The main results establish the existence of optimal control and necessary optimality conditions derived by using discrete approximations and advanced tools of variational analysis and generalized differentiation. The results obtained are expressed in terms of the initial data and allow us to calculate optimal solutions in particular settings.

The talk is based on joint work with Giovanni Colombo, Rene Henrion and Nguyen Hoang.

Room "Müggelsee" **Monday, June 25, 2012** **14:00 – 15:00**
Chair: S. Vogel

Minimax stochastic programs and beyond

Jitka Dupačová, Charles University, MFF UK, Prague, Czech Republic

In stochastic programming one assumes that uncertain values of coefficients observed in applications of mathematical programming are random and that their probability distribution P is fully specified. In practice, however, complete knowledge of the probability distribution is rare and it pays to include the existing, possibly limited information into the model. The incomplete knowledge of P is modeled by assuming that P belongs to a specified class $\mathcal{P}$ of probability distributions and the minimax approach is applied to hedge against the worst distribution belonging to the class $\mathcal{P}$. In their basic form, minimax problems deal with one- and two-stage stochastic linear programs of expectation type, with a fixed, independent of P, set of feasible solutions.

To get the class $\mathcal{P}$ one chooses compromises between the wish to exploit the existing, available information and the need to keep the minimax problem numerically tractable. A suitable stability analysis of results with respect to the choice of this class is an important issue. It has to be tailored to the type of the minimax problem, to the considered class of probability distributions and to the anticipated input perturbations.

We shall review recent suggestions on choices of classes $\mathcal{P}$ and indicate suitable sensitivity analysis techniques. We shall focus on results for the class $\mathcal{P}$ described by fixed values of the 1st and 2nd order moments. Possible extensions of the basic model to minimax problems with constraints dependent on P, with risk objective functions and multiple stages will be discussed.

Room "Müggelsee" **Tuesday, June 26, 2012** **09:00 – 10:00**
Chair: D. Klatte

DC functions: subdifferential analysis, duality and Lipschitz continuity

Juan Enrique Martínez-Legaz, Universitat Autònoma de Barcelona, Bellaterra, Spain

This talk will present a survey on the analysis of d.c. functions based on convex subdifferentials and conjugate functions, including duality theory for constrained optimization problems. In particular, a characterization of such functions in terms of quasidifferentials will also be provided, as well as a characterization of the globally Lipschitz character of a d.c. function f-g in terms of the epsilon-subdifferentials of the convex functions f and g. This last result makes part of a recent (still unpublished) joint paper with Abderrahim Hantoute.

Room "Müggelsee" **Tuesday, June 26, 2012** **14:00 – 15:00**
Chair: I. Melichercik

How to compute equilibrium prices in exchange economies with indivisible goods

Katarina Cechlarova, P.J. Safarik University, Kosice, Slovakia

The notion of competitive equilibrium in exchange economies is one of central notions in economics. We review the known results concerning the complexity of its computation in the case of indivisible goods. Special attention will be given to housing markets, where the equilibrium always exists and can be efficiently computed using the Top Trading Cycles Algorithm, if each house is unique. If there are duplicate houses then equlibrium may not exist, but its existence can be efficiently decided if agents' preferences are strict. However, the problem is NP-complete already in the case of trichotomic preferences. Here, 2-approximate equilibrium can be computed in polynomial time, but it is hard to approximate within 1.2 bound.

Room "Müggelsee" **Wednesday, June 27, 2012** **09:00 – 10:00**
Chair: B. Mordukhovich

On the joint effect of Mangasarian-Fromovitz and Constant Rank qualification conditions in stability analysis of generalized equations

Jiri V. Outrata, UTIA, Academy of Sciences of the Czech Republic, Prague, Czech Republic

The talk is devoted to local behaviour of the solution map S associated with a class of parameter-dependent generalized equations, where the multi-valued term amounts to the normal cone to a set given by inequalities. Under Mangasarian-Fromovitz and Constant Rank qualification conditions we compute the graphical derivative, the regular coderivative and the limiting coderivative of S at the reference point. This enables us to derive useful characterizations of various stability properties of S, including the Aubin property, the isolated calmness and also the tilt stability, provided the considered generalized equation amounts to stationarity conditions of a canonically perturbed nonlinear program. The computed coderivatives will further be used in deriving stationarity conditions for mathematical programs with equilibrium constraints, in which the equilibria are governed by the considered class of generalized equations. We conclude by examining a possible relaxation of the imposed qualification conditions.

Room "Müggelsee" **Wednesday, June 27, 2012** **14:00 – 15:00**
Chair: J.E. Martinez-Legaz

Optimal control of differential-algebraic equations

Matthias Gerdts, Universität der Bundeswehr, Munich, Germany

The talk discusses numerical methods for optimal control problems governed by differential-algebraic equations. Differential-algebraic equations are composite systems of ordinary differential equations and algebraic equations and arise for instance in process engineering, mechanical multibody systems, and electric circuit simulation. Globalized semi-smooth Newton methods and direct discretization methods are developed to solve such problems. Semi-smooth Newton methods aim at satisfying necessary optimality conditions numerically using nonlinear complementarity functions, while direct discretization methods are based on suitable discretization schemes and techniques from finite dimensional nonlinear optimization. Applications from automobile test-driving, robotics and process engineering will be presented.

Room "Müggelsee"	**Thursday, June 28, 2012**	**09:00 – 10:00**
Chair: W. Römisch		

Density Estimation with EpiSplines and Kernel Estimators

Silvia Vogel, Ilmenau University of Technology, Ilmenau, Germany

Good estimates for probability distributions are one of the crucial prerequisites for the successful application of stochastic programming models. Confidence bands for densities are important tools in this framework. They can be utilized to derive confidence regions for constraint sets, optimal values and solution sets of stochastic programming problems. We will consider density estimators and derive uniform concentration-of-measure results which can immediately be employed to derive confidence bands. It will be shown how a former result for univariate kernel density estimators can be extended to the multivariate case. Furthermore, we will investigate the EpiSpline method, which has been developed by R. J-B Wets and M.S. Casey. Convergence properties and concentration-of-measure inequalities will be discussed. The talk is based on joint work with Roger R-B Wets.

Contributed talks

Room "Müggelsee"	**Monday, June 25, 2012**	**10:30 – 12:30**
Chair: P. Lachout		

Optimization Problems under Two-sided Max-separable Inequatilty Constraints.

Karel Zimmermann, Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic
Martin Gavalec, University of Hradec Kralove, Hradec Kralove, Czech Republic

A max-separable function of n variables is defined as the maximum of n functions $f_j(x_j)$ of one variable x_j, $j = 1, \ldots, n$, i.e. $f(x_1, ..., x_n) = \max_{j \in J}(f_j(x_j))$, where $J = \{1, ..., n\}$.

Inequalities, on both sides of which max-separable functions occur will be called two-sided max-separable inequalities. We will consider finite systems of two-sided max-separable inequalities. A survey of properties of such inequality systems under appropriate monotonicity and structural assumptions will be presented. Using these properties various approaches to solving optimization problems with max-separable objective functions and constraints described by two-sided max-separable inequality systems will be derived. Illustrative numerical examples as well as possibilities of applications to some operations research problems will be briefly discussed.

Periodic behavior of max-t fuzzy systems

Richard Cimler, University of Hradec Králové, Hradec Králové, Czech Republic
Martin Gavalec, University of Hradec Králové, Hradec Králové, Czech Republic

Periodic behavior of complex systems described by fuzzy transition matrices is studied. Orbit periods in max-min, max-drast, max-prod and max-Lukasziewicz fuzzy algebras are compared in the presentation. By easy argument we can show that every max-min or max-drast matrix power sequences are always periodic, and the same holds for their orbits. On the other hand, when the computation is performed by the product t-norm, or the Lukasziewicz t-norm, new elements can arise in the powers of the given matrices, therefore no repetition may occur in the orbit or power sequence, and the considered orbit need not be periodic. The paper describes the computation of matrix power periods and orbit periods in the max-min, max-drast, max-prod and max-Lukasziewicz fuzzy algebra. Relations between matrix and orbit periods for individual triangular fuzzy norms, and also relations in the periodic behavior between different triangular fuzzy norms, will be shown by illustrative examples.

Application of circulant and Toeplitz max-min matrices

Hana Tomášková, University of Hradec Králové, Hradec Králové, Czech Republic
Martin Gavalec, University of Hradec Králové, Hradec Králové, Czech Republic

Investigation of matrices in max-min algebra is useful for applications connected with complex systems in manufacturing, transport or marketing, for applications working with fuzzy relations and for further topics. For special types of matrices the investigation is important because it can lead to more efficient solutions with lower computational complexity.

By max-min algebra we understand a triple (B;oplus;otimes), where B is a linearly ordered set, and oplus = max; otimes = min are binary operations on B. Matrices and vectors in max-min algebra have been studied by many authors. Eigenvectors of circulant and Toeplitz matrices in max-min algebra are considered in this contribution. Both types of matrices are determined by vector of inputs in the first row, and for Toeplitz matrix we also need the first column. Description of the eigenproblem for the above special matrices presents more information and it is simpler than in the general case.

Investigation of eigenvectors in max-min algebra is important for applications connected with reliability of complex systems and further questions.

Efficient Algorithm for Checking robustness of interval fuzzy matrices

Helena Myšková, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Košice, Slovakia
Ján Plavka, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Košice, Slovakia
Monika Molnárová, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Košice, Slovakia

The fuzzy algebra is a triple (B,min,max), where (B;$\leq$) is a bounded linearly ordered set with binary operations maximum and minimum. A matrix A over fuzzy algebra is called robust if

for each vector x over B the orbit period per(A,x) equals one. An interval matrix A over fuzzy algebra (interval fuzzy matrix) with lower bound L and upper bound U, where L, U are given matrices, is called possibly (universally) robust if there exists a matrix C from the interval matrix A such C is robust (if each matrix C from the interval matrix A is robust). The robustness of interval fuzzy matrices is studied and equivalent conditions for interval fuzzy matrices to be possibly or universally robust are given. The polynomial algorithms for checking the robustness of interval fuzzy matrices are introduced. In addition we introduce more efficient algorithms for the class of interval circulant matrices, whose rows are composed of cyclically shifted versions of a length n, to be possibly (universally) robust.

Room "Müggelsee" **Monday, June 25, 2012** **15:30 – 17:30**
Chair: K. Zimmermann

Optimal fund management with gradual contributions

Igor Melichercik, Comenius University, Bratislava, Slovak Republic

We investigate the problem of optimal asset allocation for a (pension) fund that receives contributions gradually over time. A popular rule of thumb says that one should calculate the NPV of all contributions and allocate this amount among various assets using static portfolio weights. We show that in a realistic situation with shorselling constraints this allocation is far from optimal.

Real Options with CRRA utility function and finite project life

Martin Tóth, Comenius University in Bratislava, Department of Applied Mathematics and Statistics, Bratislava, Slovakia

Real options theory provides a framework, in which investment under uncertainty can be investigated when irreversibility and flexibility with respect to the timing of decisions are involved. Although originally developed for a risk neutral investor, the approach can be modified to account for a risk averse investor. By introducing a investor maximising his expected utility we are able to derive the optimal behaviour of such an investor. Choice of CRRA utility function gives us ability to distinguish level of risk aversion and leads to constraint on its level. Another extension of the model is to consider project with finite duration. Although for infinite project, risk aversion postpones the investment. This is not necessarily the case for short projects. We examine this behaviour and also show that there exists level of risk aversion, when investor is indifferent of the project length.

Dynamic Accumulation Model with Fat-tailed Distributed Returns

Darina Graczova, Comenius University in Bratislava, Bratislava, Slovakia

In our research we focus on the modeling of portfolio returns with fat-tailed distributions that have the property to exhibit extreme large skewness and kurtosis. We focus on the normal-inverse Gaussian distribution and analyze the impact of higher moments on the optimal choice

of the portfolio composition. We consider the dynamic stochastic model for Slovak pension system and introduce the problem of optimal choice of composition in fund offered and managed by pension management institutions. The funds differ with the level of risk. The problem leads to the dynamic problem of Bellman type. The shape of the density functions are related to the numerical complications.. We discuss the distribution of the portfolio returns created by the convolution of NIG distributed assets and present the numerical solution of the Bellman integral. We perform a sensitivity analysis of the choice of the descriptive statistics of probability distribution used to model the asset returns on the accumulated sum of the future pensioner at the retirement time as well as in each time step during the saving. We compare the results considering the normal distribution and NIG distribution with different skewness and kurtosis and discuss the distribution of accumulated sum at the retirement time.

Three - factor convergence model of interest rate

Zuzana Zíková, Department of Applied Mathematics and Statistics, Comenius University in Bratislava, Bratislava, Slovakia

A convergence model of interest rates explains the evolution of the domestic short rate in connection with the European rate. The first model of this kind was proposed by Corzo and Schwartz in 2000. The term structures can be either computed exactly or by an analytic approximations. In all these models, the European rates are modelled by one-factor model. This, however, does not provide a satisfactory fit to the market data.

Our first task is therefore to find a suitable model for the European data. We obtain a very good fit using the model where the short rate is a sum of two unobservable factors. Consequently, we build the convergence model for the domestic rates based on this evolution of the European market. In this way we obtain three factor convergence model of interest rate.

For both European and domestic case, the term structures are defined by the solution of the partial differential equations for bond prices. In general, they do not have explicit solutions. Hence we suggest an analytical approximation formulae and derive their order of accuracy. We propose a calibration method which we firstly test on simulated data. Finally, we use it to calibrate the model using real market data.

Room "Müggelsee" **Tuesday, June 26, 2012** **10:30 – 12:30**
Chair: J. Outrata

A Class of Nonsmooth Newton Methods Revisited

Diethard Klatte, University of Zurich, Zurich, Switzerland

More than 20 years ago, Bernd Kummer proposed a class of nonsmooth Newton methods allowing the use of a variety of generalized derivatives in the generalized Newton equation. Local convergence analysis has been performed under a unified approach via two basic assumptions called CA (approximation condition) and CI (injectivity condition), which have special meanings depending on the derivative under use (e.g., Clarke' derivative, graphical derivative, standard directional derivative). It has turned out in the last 2-3 years that there

is some new interest in methods of this kind, also with respect to global convergence. We will recall classical and more recent results on convergence analysis and discuss some applications to critical point systems. This talk is based on collaboration with Stephan Bütikofer, ZHAW Winterthur, and Bernd Kummer, Humboldt University Berlin.

Necessary Optimality Conditions for a Optimal Control Problem Governed by an Inclusion with Discontinuous Right–Hand Side

Lukas Adam, Charles University, Prague, Czech republic

We work with a optimal control problem of a Bolza type, where the controlled system is governed by a generalized sweeping process, which is a special differential inclusion with discontinuous right–hand side. The goal of this paper is to establish pointwise optimality conditions for a local minimum. Employing a suitable constraint qualification, we restate the problem using distance functions and use the fuzzy sum rule to obtain fuzzy optimality conditions. Furthermore, we discuss the possibility of limiting the fuzzy parameter to zero and deriving pointwise optimality conditions.

Solving MINLPs with SCIP

Stefan Vigerske, Humboldt-Universität zu Berlin, Berlin, Germany

We discuss recent extensions of the constraint integer programming framework SCIP for solving mixed-integer nonlinear programs (MINLPs). Nonlinear constraints (convex or nonconvex) are handled within a linear programming based branch-and-cut algorithm by reformulation, linear relaxation, and domain propagation. In an extensive computational study, we compare the performance of our implementation with state-of-the-art solvers for MINLPs and analyze the impact of various solver components on the overall performance.

Solving Mixed Integer Problems with Chance Constraints – An Example

Thomas Arnold, WIAS Berlin, Berlin, Germany
René Henrion, WIAS Berlin, Berlin, Germany

In the talk we will explain an approach to solving mixed integer problems with chance constraints at the example of the management of a hydro power water reservoir. The introduced model relies on discretization of the decision variables but keeping the probability distribution, describing the inflow of water, continuous. We introduce binary variables into the model to describe minimum generator loads greater than zero. The optimization algorithm used to solve the optimization is based on a cut and branch approach implemented in SCIP (http://scip.zib.de/).

Estimation of the Fair Price at the Market with Partially Informed Market Maker

Martin Smid, Institute of Information Theory and Automation, Praha, Czech Republic

A lot of attention is now payed to the filtering of the microstructure noise (i.e. the fluctuations of a price due to particular events at the market).

We present a model of a market with a market maker and the orders arriving with an intensity dependent on the distance of an quoted price to the fair price. The market maker is partially informed about the value of the fair price. In order to maximize his profit, he tries to keep the "optimal" amount of the traded asset which results in a mean-reversion of the quoted price which, together with the sizes of particular trades, serves as an input of a filter estimating the fair price.

We demonstrate the estimation on the high-frequency data from several markets.

Equitable cake division

Eva Pillárová, Pavol Jozef Šafárik University, Košice, Slovakia

We deal with the problem of 'fairly' dividing a certain infinitely divisible resource, called the cake, between n players. The cake is represented by the interval $[0, 1]$ of reals. Players may have different opinions about the values of different parts of the cake.

The notion of fairness can be defined in many different ways but we shall concentrate on proportional equitable divisions, i.e. such that the values of pieces assigned to all players are equal (according to their valuations) and simultaneosly not smaller than $1/n$.

We show that for any number n of players an equitable and proportional division exists, giving each player a contiguous piece of cake. Our next result concerns the existence of a finite equitable algorithm for n players. We show that there is no such finite algorithm already for three players. Therefore we propose an algorithm that for any given $\varepsilon > 0$ finds, in a finite number of steps, a simple division such that the values assigned to players differ by at most $\varepsilon > 0$.

Oligopolistic competition in an electricity spot market with production bounds

Michal Cervinka, Academy of Sciences of the Czech Republic, Institute of Information Theory and Automation, Prague, Czech Republic
Didier Aussel, University of Perpignan, Perpignan, France
Matthieu Marechal, University of Perpignan, Perpignan, France

The day-ahead electricity market models are based on noncooperative Nash equilibrium models in which each producer aims to maximize his profits while a global market regulator, called the ISO, is minimizing the total social costs, usually costs of production. Following previous works, we include in the model the losses due to transmission along the lines together with the fact that production cost function could be quadratic. Our aim is to investigate the influence of

the existence of production bounds. We first emphasize the importance to take these bounds into account. We study some qualitative and quantitative properties of the proposed market model.

Strategic bidding and generalized Nash equilibrium on the EPEX Spot

Konstantin Emich, Humboldt University Berlin, Berlin, Germany
René Henrion, Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany

We present a model of electricity trading in day-ahead market, which is a generalized Nash equilibrium problem (GNEP). In order to obtain an optimal bidding strategy each market participant solves a quadratic mixed-integer problem.

Room "Müggelsee" **Wednesday, June 27, 2012** **10:30 – 12:30**
Chair: J. Dupačová

Quantitative stability of stochastic generalized equations

Werner Römisch, Humboldt-University Berlin, Berlin, Germany
Huifu Xu, University of Southhampton, Southhampton, Great Britain

We consider a stochastic generalized equation (SGE) where the underlying function is the expected value of a random set-valued mapping. SGEs characterize optimality conditions for stochastic optimization equilibrium problems. We derive quantitative continuity of solution set mappings to SGEs with respect to the variation of the underlying probability measure on some metric space. The results are applied to the stability analysis of stationary points of classical one stage and two stage stochastic optimization problems, two stage stochastic programs with equilibrium constraints and stochastic programs with second order dominance constraints.

Quasi-Monte Carlo algorithms and two-stage stochastic programs

Holger Heitsch, Humboldt-University, Berlin, Germany
Werner Römisch, Humboldt-University, Berlin, Germany

Quasi-Monte Carlo algorithms are studied for designing discrete approximations of two-stage linear stochastic programs. Their integrands are piecewise linear, but neither smooth nor of bounded variation. We show that under some weak geometric condition on the two-stage model all terms of their ANOVA decomposition, except the one of highest order, are smooth and, hence, lattice rules may applied with an optimal rate of convergence.

Efficient Computation of Optimal Weights for Lattice Rules in High Dimensional Integration

Hernan Leovey, Humboldt Universitaet zu Berlin, Berlin, Germany

We present new methods for accurate evaluation and bounding of mixed derivatives of functions $f : \mathbb{R}^d \to \mathbb{R}$ by means of algorithmic differentiation (AD). The new AD techniques enable us to compute optimal weights required for construction of good shifted lattice rules. Lattice rules are one of main techniques of Quasi-Monte Carlo for high dimensional integration. They are an efficient integration method in many examples of two-stage stochastic programs, where the rate of convergence can be $O(\frac{1}{N})$ even when the integrands are functions with "kinks".

The weights define the embedding of a function on a weighted (unanchored) Sobolev space, and are used by the component–by–component construction of generator vectors for lattice rules. If the function at hand exhibits low effective dimension in truncation or superposition sense, (mixed-)derivative information can be used to approximate the (semi)norm of the ANOVA effective part of the function, resulting in a simplification to fix the weights. For the full dimensional smooth case, we can compute using AD (product and order dependent) bounds for all involved mixed derivatives. This approach results with an explicit expression for the so called optimal "product and order" dependent weights.

We show numerical results comparing the different type of weights in examples related to finance.

A Linear Formulation of High-order Stochastic Dominance Criteria

Milos Kopa, Charles University in Prague, Faculty of Mathematics and Physics, Prague, Czech Republic
Thierry Post, Koc University Istanbul, Istanbul, Turkey

We develop and implement a linear formulation of general Stochastic Dominance criteria for discrete probability distributions. Our approach is based on a piece-wise polynomial representation of utility and its derivatives and can be implemented by solving a relatively small system of linear inequalities. This approach allows for comparing a given prospect with a discrete set of prospects as well as for comparison with all linear combinations of a set of prospects. Moreover, we present a dual formulations of efficiency tests. An empirical application to historical stock market data suggests that the passive stock market portfolio is highly inefficient relative to actively managed portfolios for all investment horizons and for nearly all investors.

Room "Müggelsee" **Wednesday, June 27, 2012** **15:30 – 17:30**
Chair: M. Gerdts

An optimal control problem in the optimization of production lines

Chantal Landry, Weierstrass Institute, Berlin, Germany
Matthias Gerdts, University of the Federal Armed Forces at Munich, Munich, Germany
René Henrion, Weierstrass Institute, Berlin, Germany
Dietmar Hömberg, Weierstrass Institute, Berlin, Germany
Wolfgang Welz, Technical University of Berlin, Berlin, Germany

In a competitive industry, production lines must be efficient. In practice, this means an optimal task assignment between the robots and a collision-free motion planning of each robot. The mathematical model to improve the production lines is based on an interplay between discrete and continuous optimization. The talk will mainly focus on the computation of the fastest collision-free trajectory of each robot. This trajectory is the solution of an optimal control problem where the collision avoidance is included as state constraints. The resulting problem is solved by a sequential programming method where the initialization is issued from discrete optimization.

How does the effort a mother bird expends on her offspring depend on the attractiveness of her mate?

Dana Botesteanu, Mount Holyoke College, South Hadley, MA, USA
Frances Goglio, University of Wisconsin, Madison, WI, USA
Yicong Yong, University of Florida, Gainesville, FL, USA
Tucker Gilman, National Insitute for Mathematical and Biological Synthesis (NIMBioS), Knoxville, TN, USA
Tony Jhwueng, NIMBioS, Knoxville, TN, USA

The Differential Allocation Hypothesis (DAH) proposes that selection would favor individuals in a population that invest more resources in their current reproductive attempt when paired with a high-quality mate, at the expense of future reproductive attempts. Additionally, it is argued that differential allocation should take place to a greater extent in polygamous species than in those that are strictly monogamous, since these species are more likely to engage in extra-pair copulations or mate switching. A mathematical model was developed to illustrate the relationship between male attractiveness and female fitness, while taking into account viability and sexual selection and also allowing varying levels of extra-pair paternity (EPP). The model provides a theoretical framework for determining whether DAH depends on EPP, assuming that male attractiveness only signals indirect fitness benefits.

Orbit period in max-t fuzzy algebra

Zuzana Němcová, University of Hradec Králové, Hradec Králové, Czech Republic
Martin Gavalec, University of Hradec Králové, Hradec Králové, Czech Republic

Periodic behavior of orbits characterizes the long-term development of complex systems described by fuzzy transition matrices. The orbits periods in the well-known max-min fuzzy algebra have been earlier studied by several authors. Computation of orbit periods in max-drast, max-prod and max-Lukasziewicz fuzzy algebra is considered in the contribution. When powers of a matrix in max-min or max-drast algebra are computed, new elements are not created. Therefore, sooner or later, a repetition in the power sequence must occur. As a consequence, a max-min or max-drast matrix is always periodic, and the same holds for orbit behavior. In contrast, using the product or the Lukasziewicz t-norm in the computation, new elements can arise in the powers of the given matrices, therefore it can happen that there is no repetition in the orbit or power sequence, and the considered orbit is not periodic. Comparison of various orbit periods for the above mentioned max-t fuzzy algebras will be presented.

On strong robustness, robustness and weak robustness of interval fuzzy matrices

Štefan Berežný, Technical University of Košice, Košice, Slovak Republic
Ján Plavka, Technical University of Košice, Košice, Slovak Republic

Strong robustness, robustness and weak robustness of interval fuzzy matrices (matrices over (max,min)-algebra) are studied and similar properties as in the case of classical fuzzy matrices are proved. It is shown that a robustness of an interval fuzzy matrices is well-defined using the definition of classical robustness. We present a characterization of strong robustness, robustness and weak robustness of interval fuzzy matrices and as a consequence, algorithms for checking the various type of robustness of a given interval fuzzy matrix are introduced.

Room "Wernsdorfer See" **Wednesday, June 27, 2012** **15:30 – 17:30**
Chair: M. Kopa

Probabilistic constraints as a multifunction

Petr Lachout, Charles University in Praha, Praha, Czech Republic

Considering an optimization program with random inputs one has to construct an appropriate deterministic equivalent to the original problem. Objective function can be converted to its mean or to mean of a utility function. Constraints are more delicate. Probabilistic constraints are one of the employed form. We will consider them as a multifunction depending on available knowledge and intend to discuss its smoothness.

Joint chance constraint programming for blending problem in brass casting industry

Andris Möller, Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany

Brass is an alloy of copper and zinc which also includes small amounts of other metals as lead, iron, tin, aluminium, antimony and nickel. In a first step of the production process raw materials are blended and melted in a melting furnace. One type of raw materials are low-cost scraps whose compositions may be stochastic. Other types of raw materials are more expansive pure materials and scrap products. The blending problem consists in the determination of the cheapest blend of available raw materials while the semi-product of the melting operation should satisfy some specification limits on the ratios of metal concentrations.

Sakallı et al. (2011) developed a stochastic single blend model with individual chance constraints. Compared to joint chance constraint this constraints are easy to solve but its solution may be much less robust. Joint chance constraints applied to this model are of the type

$$\varphi(x) := \mathrm{P}(\alpha(x) \leq T(x)\xi \leq \beta(x)) \geq p$$

where p is the required probality level and $\alpha(x)$, $\beta(x)$ and $T(x)$ are vectors and a matrix, respectively, depending on the decision vector x representing the amount of raw materials in the blend. The solution of the optimization problem, e.g. by means of a cutting plane method, requires the computation of function values and gradients of $\varphi(x)$. An explicit derivative formula for $\varphi(x)$ will be presented.

Numerical results based on the data of Sakallı et al. (2011) will be reported.

Stability of convex approximation of chance-constrained problems with structural dependence

Michal Houda, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, Prague, Czech Republic

In chance-constrained problems, the convexity of the constraint set is considered important from the theoretical and practical point of view. It is known that a suitable combination of a concavity property of the probability distribution and concavity of constraint mappings are sufficient conditions to the convexity of the resulting constraint set. We are using the concept of r-decreasing density developped by Henrion, Strugarek (2008) but we assume furthermore a structural dependence assumption: constraint rows are not required to be independent. The resulting constraint set is non-convex but can be approximated by a convex one. We develop the idea and, applying stability results on optimal values and optimal solutions, that these values and solutions remain stable under common stochastic programming assumptions. The results are accompanied by the numerical illustration.

Chance constrained problems: penalty reformulation and performance of sample approximation technique

Martin Branda, Charles University, Prague, Czech Republic

If the constraints in an optimisation problem are dependent on a random parameter, we would like to ensure that they are fulfilled with a high level of reliability. The most natural way is to

employ chance constraints. However, the resulting problem is very hard to solve. We propose an alternative formulation of stochastic programs using penalty functions. The expectations of penalties can be left as constraints leading to generalised integrated chance constraints, or incorporated into the objective as a penalty term. We show that the problems are asymptotically equivalent under quite mild conditions. We discuss applications of sample-approximation techniques to the problems and propose rates of convergence for the set of feasible solutions.. We will direct our attention to the case when the set of feasible solutions is finite, which can appear in integer programming. The results are then extended to the bounded sets with continuous variables and mixed-integer sets. Additional binary variables are necessary to solve sample-approximated chance-constrained problems, leading to a large mixed-integer nonlinear program. On the other hand, the problems with penalties can be solved without adding binary variables; just continuous variables are necessary to model the penalties. The proposed approaches are applied to various stochastic programming problems leading to comparably reliable solutions.

Room "Müggelsee" **Thursday, June 28, 2012** **10:30 – 12:30**
Chair: H. Heitsch

A Remark on Heavy Tails in Stochastic Programming Problems

Vlasta Kaňková, Institute of Information Theory and Automation of the AS CR, Prague, Czech Republic

Deterministic optimization problems depending on a probability measure correspond very often to economic and financial applications. Since mostly there the "underlying" probability measure is completely unknown, the problem has to be often solved on the data basis. It means that empirical measure replaces the unknown theoretical one. Of course, estimates of an optimal value and optimal solutions can be obtained only by this approach. In the stochastic programming literature great effort has been paid to investigate "good" properties of the above mentioned estimates. The aim of the talk will be to analyze the dependence of convergence rate on "underlying" probability measure. Especially we try to summarize cases for which the convergence rate is acceptable. Our results include heavy tails distribution with shape parameter in the open interval (1,2) and some types problems in which dependence on the probability measure is not linear. At the end these results will be applied to multistage problems with autoregressive "underlying" random sequences and some types of stochastically dependent data.

Expected utility maximization with risk managment and strategy constraints

Csilla Krommerova, Comenius University, Bratislava, Slovakia

We investigate a problem of power utility maximization in a constrained model. We consider convex constraints on the portfolio strategy and risk management. For convex constraint such as prohibiting short positions, the portfolio strategy can be obtained as the argmax of a deterministic function. Considering risk management, such as protecting the value of the

portfolio from declining below a certain level, shrinks the benchmark portfolio weights by a proportion. We conclude that considering both type of constraints simultaneously results in portfolio weights being a proportion of those portfolio weights that are obtained from the model with only convex constrains on the portfolio strategy.

On Linear Vector Optimization and Applications in Finance

Andreas Löhne, MLU Halle-Wittenberg, Halle, Germany
Andreas Hamel, Yeshiva University, New York, USA
Birgit Rudloff, Princeton University, Princeton, USA

An introduction to Linear Vector Optimization and Benson's algorithm is given. Recent improvements of the algorithm include the case of arbitrary polyhedral ordering cones, which is important for applications in Finance. We formulate the problem to compute the set of super-hedging prices in incomplete markets with transactions costs as a sequence of linear vector optimization problems and solve it with new variants of Benson's algorithm. A second application concerns set-valued measures of risk.

Stability of solutions and optimal values to chance constrained programs with Gaussian data

Rene Henrion, Weierstrass Institute Berlin, Berlin, Germany

The general stability theory of chance constrained optimization problems is well established. In particular, explicit conditions on the problem data are known which guarantee the Lipschitz or Hölder continuity of optimal values or solutions with respect to the Kolmogorov distance between the original and the perturbed distribution of the underlying random vector. On the other hand, these results involve unknown constants which make it difficult to apply the results, for instance, in order to derive a sample size needed in empirical approximation in order to guarantee a certain precision of the optimal value or of the solution. We show, that in the case of Gaussian distributions, the Lipschitz constant for estimating stability of optimal values can be made explicit. We also show that despite the existence of quantitative stability results for empirical approximation of solutions, there may be an excessively large sample size needed even in trivial dimension 2 in order to get a reasonable estimate of the solution at a reasonable probability.

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